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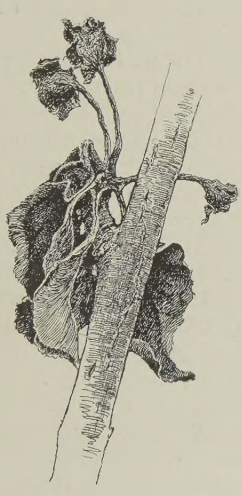
Department of Plant Pathology

FIRE BLIGHT OF PEARS, APPLES, QUINCES, ETC.



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By H. H. WHETZEL and V. B. STEWART

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FIRE BLIGHT OF PEARS, APPLES, QUINCES, ETC.

This bulletin has been prepared to meet the constant and increasing demand from growers for information on this most common and destructive bacterial disease of fruit trees. There is nowhere brought together in available form a concise statement of our present knowledge of this malady. The writers have sought to present as clearly as they can the main facts in regard to the history, symptoms, cause and control of this disease. The data here presented have been derived from the recorded investigations of other workers and from our own observations and experiments extending over a period of several years. It is not our purpose to present the details of our experiments. We shall give briefly those results and conclusions that appear to be of immediate and direct value to the grower. We have in preparation a full and comprehensive monograph of this disease to be presented when experiments and researches now under way have sufficiently progressed to warrant their presentation to the public. The junior writer is devoting his entire time and attention to a careful study of this disease, particularly in relation to its occurrence and control in nursery stock. This work is being conducted co-operatively with the growers under an Industrial Fellowship established by C. W. Stuart and Co., Nurserymen, Newark, N. Y. During the season of 1909, co-operative experiments were conducted in a field laboratory on a fruit farm near Oswego, N. Y. This investigation was also largely supported by the grower, Mr. Ira Pease, who placed this orchard under our supervision and provided salary and traveling expenses for Mr. E. W. Mitchell, who had direct charge of the work. We shall be glad to consider co-operative experiments with other growers who may so desire. Correspondence in regard to this matter is especially invited. Address, Prof. H. H. Whetzel, Plant Pathologist, College of Agriculture, Ithaca, N. Y.

LITERATURE

The following list of publications does not include, by any means, all that has been written on this subject, but we believe does contain the main facts of the history, cause and control as represented by previous investigation. The publications have been arranged in chronological order. Many of them are not now available except in libraries.

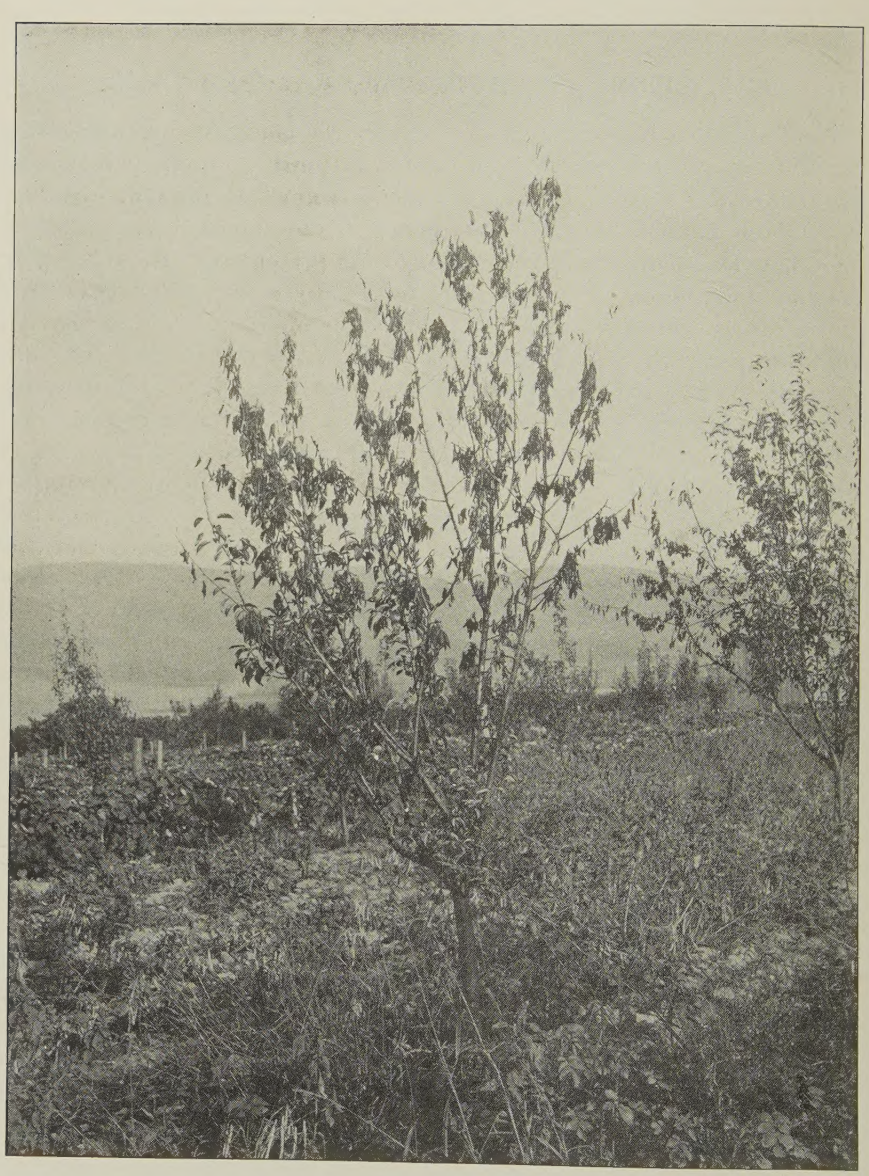

FIG. 5.—*Killed by the Blight*

'94	Denning, W. M.	On the Decay of Apple Trees. Trans. Soc. For Promotion of Agriculture, etc. I (Pt. 2):219–222. 1794. (See also 2d Edit., 1801:185–187.)
'81	Burrill, T. J.	Anthrax of Fruit Trees: or the so-called Fire Blight of Pear or Twig Blight of Apple Trees. Proc. Am. Assoc. Adv. Sci. 29:583–597. 1881.
'81	Burrill, T. J.	Blight of Pears and Apple Trees. Ill. Indus. Univ. Rep. 10:62–84. 1881.
'85	Arthur, J. C.	Proof that the Disease of Trees Known as Pear Blight is Directly Due to Bacteria. N. Y. (Geneva) State Exp. Sta. Bul. 2:1–4. 1885.
'86	Arthur, J. C.	Pear Blight. N. Y. (Geneva) State Exp. Sta. Rep. 1885:241–248. 1886.
'87	Arthur, J. C.	Pear Blight. N. Y. (Geneva) State Exp. Sta. Rep. 1886:275–289. 1887.
'87	Arthur, J. C.	Important Articles on Pear Blight. N. Y. (Geneva) State Exp. Sta. Rep. 1886:300–315. 1887.
'96	Waite, M. B.	Cause and Prevention of Pear Blight. U. S. D. A. Year Book 1895:295–300. 1896.
'98	Waite, M. B.	Life History and Characteristics of the Pear Blight Germ. Proc. Amer. Assoc. Adv. Sci. 47:427–428. 1898.
'06	Waite, M. B.	Pear Blight and its Control in California. State Hort. Comm. of Calf. (Special Report) 1906:1–20. 1906.
'02	Jones, L. R.	Studies on Plum Blight. Centrbl. f. Bakt. Parasitenk. u. Infek. 2 (Abt. 11) :835–841. 1902.
'03	Paddock, Wendell	An Apricot Blight. Colorado State Exp. Sta. Bul. 84:1–14. 1903.
'06	Whetzel, H. H.	The Blight Canker of Apple Trees. N. Y. (Cornell) Exp. Sta. Bul. 236:99–138. 1906.
'09	Sackett, W. G.	Some Bacterial Diseases of Plants. Colorado State Exp Sta. Bul. 138:6–14. 1909.

TREES AFFECTED

The pear, quince, apple, hawthorn (Cratægus), mountain ash, plum, apricot and a few ornamentals belonging to the apple family are known to be affected by this disease. The pear and quince suffer most, although the apple is often seriously injured and may be killed, particularly young trees. Plums are rarely attacked, but Jones ('02) has proved conclusively that the disease will attack and kill the twigs of the Cheney plum (*Prunus Americana Nigra*). The senior author has also observed what appeared to be this disease killing prune trees. It is not known to occur in the cherry or the peach.

Varietal susceptibility and resistance. It has long been observed that varieties of pears appear to differ in regard to their susceptibility to this malady. Those varieties most susceptible, i.e., most frequently and severely attacked, according to Sackett ('09), are Bartlett, Flemish Beauty and Clapp's Favorite, while among those especially resistant

'02	Jones, L. R.	Studies on Plum Blight. Centrbl. f. Bakt. Parasitenk. u. Infek. 2 (Abt. 11) :835.
'09	Sackett, W. G.	Some Bacterial Diseases of Plants. Colorado State Exp. Sta. Bul. 138:13.

are Kiefer, Seckle and Anjou. We believe most growers will agree with this, although it is not rare to see Kiefers, for example, severely attacked by the disease. The same variety will suffer more in one section or in one season than in another. Among the apples, the crab and its allies are most severely attacked; of the other varieties, no strikingly constant difference in susceptibility has been recorded. The whole question of varietal susceptibility to this disease is, we believe, so bound up with other factors, such as source of infection, abundance of disseminating agents (insects), and the like, that only a series of carefully conducted infection experiments on a large number of varieties at the same time and under the same conditions can give correct conclusions. Suffice it to say that all varieties of apples and pears are known to suffer at times to a greater or less extent from this disease.

Manuring, cultivation, etc., as related to severity. It is the common belief of growers, horticulturists and pathologists that, in general, cultivation, the application of nitrogenous manures, or anything that tends to induce rapid and succulent growth favors the serious development of Blight, at least in pear trees. So far as the writers are able to discover, this general opinion is based alone on observation. No carefully conducted experiments appear to have been made to determine anything definite on this phase of the question. After having seen old pear trees that had stood in the sod all their lives, with no food other than that which they could wrest from the sodded soil of a stony hillside, blight to the ground in a single season, the writers reserve judgment until proof is forthcoming. In the meantime we advise growers to cultivate their pear orchards if they desire crops of fruit and depend on tried methods of controlling the disease, as indicated in the latter part of this bulletin. In this view we are supported by Prof. U. P. Hedrick of the State Experiment Station at Geneva, N. Y., who after several years of careful observation on this point is of the opinion that cultivation and manuring do not play the important part in Blight epidemics commonly attributed to them.

THE DISEASE

Names. Blight, Pear Blight, Fire Blight, Blossom Blight, Twig Blight, Fruit Blight, Sun Scald, Canker and Blight Canker are among the names frequently given to this malady on different kinds of trees or different parts affected. The term "Fire Blight" is perhaps the most appropriate since it applies equally well to the characteristic symptoms of the disease on any of the trees on which it is now known

FIG. 6.—*The Blossom Blight. Note the canker about the base of the spur.*

FIG. 7.—*Twig Blight. Note that it began at the very tip.*

FIG. 8.—*Fruit Blight. Note the oozing drops on the diseased and shrunken fruit.*

FIG. 9.—*Canker on limb of tree. Note the crack indicating the limit or margin of the canker.*

Symptoms of the Blight

to occur. Whether it is the blighting of the blossom clusters (Fig. 6), the dying of the growing tips of the twigs (Fig. 7), or the formation of dead areas or cankers in the bark of limbs or body (Fig. 8), it is one and the same disease—the Fire Blight. It is the same disease whether it appears on the pear, the apple or the quince, and is readily and commonly transmitted from one to the other.

History. This disease was first observed about 1780 in the Hudson River Highlands by William Denning ('94), a fruit-grower of that section. It very probably occurred as a disease of some of the indigenous wild crab apples, wild thorns or wild plums of eastern North America before the introduction of cultivated fruits. From the wild fruit trees it readily spread to the cultivated varieties as they were introduced, and as orchards became numerous and more contiguous it gradually worked its way westward over the Alleghany Mountains and into the Mississippi valley until in about 1876 to 1880 it had become so destructive in the orchards of Illinois and adjoining states as to furnish one of the chief topics of discussion at the state and county horticultural society meetings of that period, as witness the Annual Reports of the Illinois State Horticultural Society during these years. It was for a long time con-

FIG. 10.—*"Hold-over" canker in large limb of old apple tree. Rough bark cut away to show limits of the canker. Note the base of the sucker near the center by the blighting of which the bacteria gained entrance to the tender tissues of the bark.*

'94 Denning, W. M. On the Decay of Apple trees. Trans. Soc. for Prom. Agriculture, etc. 1:185. (Second Edition 1801.)

fined to the regions east of the Rocky mountains, but in 1903, despite the claims of the exploiters of the fruit regions of California, that their's was a country in which the Blight could not thrive, it suddenly made its appearance in the pear orchards of that State and wrought such havoc in a few years as has seldom been known in a fruit-growing country.

Distribution. This disease, which is without doubt of American origin, is now known throughout the United States and Canada in nearly every section where fruit is grown. It is, however, confined to North America. It is not certainly known to occur in any of the countries of Europe or in South America or Australia, although there has been more or less chance of introducing it through stock imported from this country. Whether its restriction to this continent is to be attributed to the special vigilance of those who have imported fruit trees from America or to the habit of the parasite in passing the winter alive, usually only in cankers on relatively large trees (Fig. 10), is not certain. We are inclined to regard the latter as the more probable explanation.

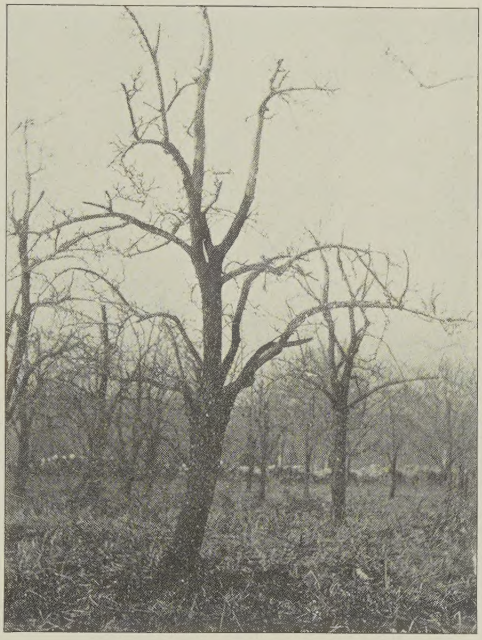

FIG. 11.—*After the pruning made necessary by one season of the unchecked ravages of the Blight, in old Bartlett Pear trees.*

Economic importance. This is the most destructive and the most dreaded disease of fruit trees, particularly of the pear. It is of a distinctly epidemic nature, appearing suddenly in virulent form in a locality, often wiping out entire orchards or injuring the trees so severely that several years are required for recovery from the effects of the attack (Fig. 11). It may not again appear to a destructive extent in the same locality for ten or fifteen years. Nevertheless it is to be found every season to a limited extent in any locality, ready when the proper combination of conditions arises to spread rapidly and again work havoc.

An epidemic of this disease means not only the loss of the season's crop but also the loss of entire trees (Fig. 5), or at least much of the bearing wood (Fig. 11), which is the product of years of growth and the replacing of which will require years more. Aside from the actual money loss there is the discouragement which always comes with such an experience. The grower with the prospect of a repetition of such a disaster before him is loath to invest more time and money in a crop subject to such losses. Many men in this and other states have given up pear-growing chiefly because of the ravages of this disease. The disease often appears also in nursery stock, where in the actively growing shoots of the young trees it spreads rapidly. The disease broke out in the nurseries about Dansville, N. Y., in 1908, in many cases wiping out entire blocks of apples, pears, and quinces. Of the sixty odd growers of nursery stock in that section, scarcely one escaped heavy losses from the epidemic.

Symptoms. It seems hardly necessary to describe the signs or symptoms by which this disease is to be recognized. The growers generally know them only too well. Figures 6 to 9 indicate fairly well the appearance of the disease on limbs, blossoms, twigs and fruit. The most striking symptom to be recognized by the grower is the twig or limb with dead, brown or black leaves clinging to it (Fig. 18), contrasting sharply with the dark green foliage in summer and the naked branches of the trees in winter. In no other disease of our fruit trees do the leaves cling so tenaciously to the dead branches. The effect is not unlike that resulting from scorching by fire or injury by frost. It is from this appearance that the name Fire Blight has been appropriately applied.

The cause of the disease. The disease has long been known to be due to a species of bacteria (*Bacillus amylovorus* (Burr) De Toni) which, when introduced into the growing parts of the tree, for example the blossoms or young shoots, multiply rapidly, feeding upon the tissues and secreting poisonous substances that kill the affected part. The bacteria which are responsible for this destruction are very minute rod-shaped plants (Fig. 12), so small that 2,000 of them end to end would be required to span an inch. They are, of course, microscopic and can be seen only when magnified several hundred times under the microscope. They are covered with fine hair-like flagella by means of which they swim about in the juices of the diseased tissues of the host. During moist weather they ooze forth in sticky, milky masses from diseased twigs, blossoms or cankers. They multiply by dividing into two at the middle (Fig. 12), growing to normal size and dividing

again, repeating this every half hour or so, as long as food, water and proper warmth prevail. They do not travel through the sap tubes of the plant, as is often supposed, but slowly work their way through and between the cells of the bark, spreading thus into the healthy part of the twig or limb, and kill it. They are able, even under the most favorable conditions, to penetrate but a few inches a day.

That these minute bacteria are the true and only cause of this disease has been demonstrated many times. Dr. T. J. Burrill ('81), Botanist of the Illinois Experiment Station, who first discovered the true cause of this disease, found, as have many investigators after him, that these minute plants are always present in great numbers in the blighted bark even along the advancing margin of the disease. He further found that when these bacteria were introduced by means of a needle into growing fruits or the tips of growing shoots of perfectly healthy trees, the characteristic symptoms of the disease appeared in about nine days; *the inoculated shoots blighted.* This experiment has been many times repeated by other investigators and always with the same result. Any grower may convince himself on this point by making inoculations from a freshly blighted twig into healthy, growing shoots of pears or apples with a common needle. The inoculation should be made in the evening or on a rainy or cloudy day. As further proof that these bacteria are the responsible agents, numerous investigators, including the writers of this bulletin, have many times obtained the organisms in pure cultures from diseased trees, grown them in beef broth, and by inoculation with them from these cultures into healthy trees of apple, pear and quince, have readily and uniformly produced the characteristic blighting. *There is no longer any question as to the cause of this disease.*

FIG. 12.—*Bacillus amylovorus, the bacteria that cause the Blight. Note that they multiply by simply dividing into two.*

These bacteria are carried from tree to tree and introduced into blossoms or growing shoots by insects of various kinds (Fig. 13). Waite

'81 Burrill, T. J. Blight of Pear and Apple Trees. Ill., Ind. Univ. Rep. 10:67.

('98) has proved that flies and wasps carry the bacteria from oozing cankers to opening blossoms and from these to others, thus spreading the Blossom Blight through the orchards. Our own observations tend to show that the aphides and leaf hoppers are largely the responsible agents in introducing the bacteria into the tips of growing shoots, while the same insects and the curculio frequently introduce them into wounds which they make in the fruit, thus giving rise to Fruit Blight (Fig. 14). Man, himself, may be the unwitting or careless agent by which these minute parasites find their way into cuts or wounds made when cutting

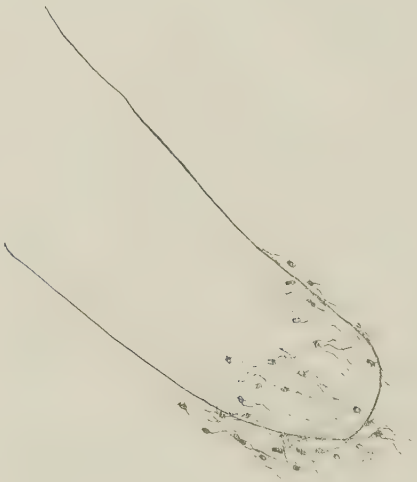

FIG. 13.—*Claw from bee's foot with Blight bacteria on and about it to show the relative size.*

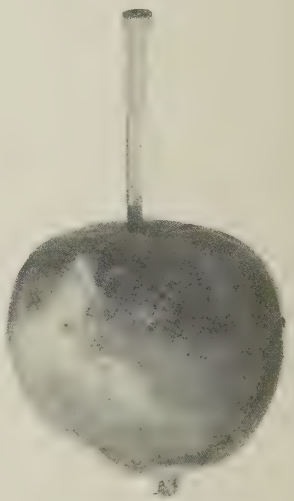

FIG. 14.— *Blighted apple. Bacteria introduced into fruit by curculio. Note the wound and oozing drops.*

out blighted limbs or in pruning the orchard (Fig. 15.) It has frequently been demonstrated that the Blight bacteria may be carried to the healthy trees on pruning tools.

These bacteria pass the winter in some of the cankers in the bark of the body or limbs of the tree (Fig. 6). The bacteria remain alive only along the margin of the canker next to the healthy bark, and only in those cankers that are more or less protected from drying out. These few cankers in which the bacteria survive the winter are called " hold-over " cankers. There is no way of distinguishing them from the cankers in which the bacteria are all dead. There is some evidence that under

'98 Waite, M. B. Life History and Characteristics of the Pear Blight Germ. Proc. Amer. Assoc. Adv. Sci. 47:427.

especially favorable conditions the parasite may also live over in blighted shoots or twigs. With the rise of sap and the increased temperature of spring the bacteria in these hold-over cankers become active, multiply and spread into the adjoining healthy bark. Here they increase to such an extent that on warm, rainy days they ooze from the lenticels and cracks in the diseased bark as thick syrupy drops of a dirty white or brown color (Fig. 16). This oozing from hold-over cankers usually takes place *first*, about the time the blossoms are opening. Wasps and flies visit these cankers to sip the sweet ooze, and becoming smeared with it from head to toe (Fig. 13) fly away to the opening blossoms. Here some of the bacteria of which the ooze is composed are left behind in the nectar of the flower. They multiply rapidly in the sweet solution and the next bee visitor unwittingly carries the fatal germs to all the succeeding blossoms that are visited. The bacteria penetrate the tender tissues of the flower and within nine or ten days blossom clusters here and there over the trees begin to turn black and wither, followed shortly by the wilting and blackening of the leaves on the spur. *Blossom Blight* (Fig. 6) is the result. During rainy weather the bacteria ooze from these blighted blossoms and are carried by plant lice, leaf hoppers and other sucking insects to the tips of the twigs that are now growing rapidly; here, in sucking the sap the insect introduces the bacteria into the tender tissues where they multiply rapidly, producing in a few days the characteristic "*Twig Blight*" (Fig. 7). Sometimes the bacteria are introduced by insects into the green fruit, where they find an abundance of proper food and moisture and soon the fruit shows the symptoms of the disease. The loss from Fruit Blight (Fig. 8) is frequently quite heavy, though it is seldom associated in the mind of the grower with the Twig Blight. The bacteria commonly work their way down the spur to the limb, spread into the surrounding bark and form cankers (Fig. 6). Where watersprouts or shoots are allowed to grow

FIG. 15.—*Blighted stub resulting from introduction of bacteria on the pruning saw.*

from the body and limbs of the trees the Blight finds conditions most favorable. Introduced by an insect into the tip of one of these succulent shoots, the parasites multiply rapidly and apparently become more

FIG. 16.—*Cankered limb showing exuding milky drops. The sticky sap is made up almost entirely of the blight bacteria.*

virulent as they proceed downward, finally reach the limb of the tree and spread about the base of the shoot into the bark. Cankers are usually formed about the base of the blighted blossom-spur or water-sprout (Fig. 17). Some of these cankers, as pointed out above, serve

to harbor the bacteria through the winter and supply a source of infection for the following season. The whereabouts of the Blight bacteria are thus accounted for throughout the year, and it should be easy now for the grower to see where they come from in the spring. It is certain that unless these bacteria are introduced into the trees by insects or by the grower himself, no Blight will result. The source of infection may be in an old neglected pear or apple tree in the back yard or in the fence row. A single old tree of this sort will often serve as a source of infection to orchards within a radius of several miles. It is also worth noting that the disease seldom appears in a young orchard until the trees begin to bear, that is, present blossoms for inoculation by insects. In a block of quinces in the nursery this season, out of 38 blossoms appearing on the trees, 33 were observed to blight.

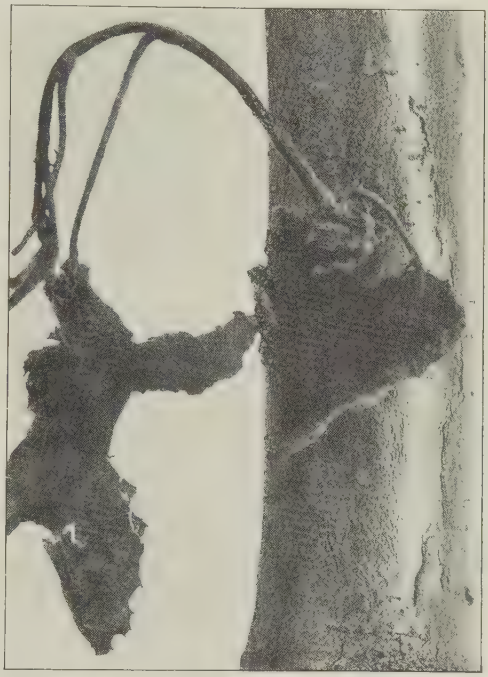

FIG. 17.—*Cankers almost always appear about the base of the blighted spurs or watersprouts.*

Not all the factors which contribute to the appearance of this disease in epidemic form are yet known. However, it is evident that there must be (1) a favorable source of infection (hold-over cankers); (2) abundance of the proper disseminating agents (insects); and (3) favorable weather conditions (warm, rainy or cloudy) at blossoming time, and during the rapid growth period of the twigs and shoots. The proper combination of these factors together, perhaps, with others not so evident at present, undoubtedly accounts for the periodic appearance of this disease in such virulent form.

CONTROL OF THE DISEASE

It has been pretty definitely shown that no method of protecting the trees by means of sprays is effective. The very nature of the method

of introduction of the causal organism into the tree precludes this as an effective means of control. If we were able to determine definitely what insects are responsible for the dissemination of the bacteria in each case, it might be possible to control the disease by destroying the insects. Thus far we believe this method has not been tried.

Making the trees immune by the introduction of different substances into the sap has not as yet been definitely proved to be successful despite the claims made by many manufacturers of Blight remedies. The

FIG. 18.—*Pear tree in autumn after having been treated with Callahan's Blight Specific the previous winter. Note the dead leaves clinging to the limbs that blighted during the summer.*

senior writer has had this phase of the problem under investigation for several years. One of these so-called remedies, viz., Callahan's Blight Specific, has been thoroughly tested and proved to be not only absolutely worthless as a preventive of Blight (Fig. 18) in pears, but positively injurious to the trees, as shown in Fig. 19. This remedy consists of a gray, green powder, which is to be inserted into a hole bored in the base of the tree, firmly tamped down and confined with a soft wooden plug tightly driven into the mouth of the hole. Following directions explicitly, during the early winter of 1908 six large pear

trees on the University farm, which had blighted badly the previous season, were treated with this Specific. The following summer the treated trees suffered even more severely than the previous year, and more than the untreated trees near by in the same orchard. Moreover, a strip of bark and the wood for two feet above and below the hole was killed and rot fungi entered and began a heart-rot of the trees. A chemical examination of the powder by Professor Cavanaugh of the Department of Agricultural Chemistry, showed it to be 92% sulfur, a little

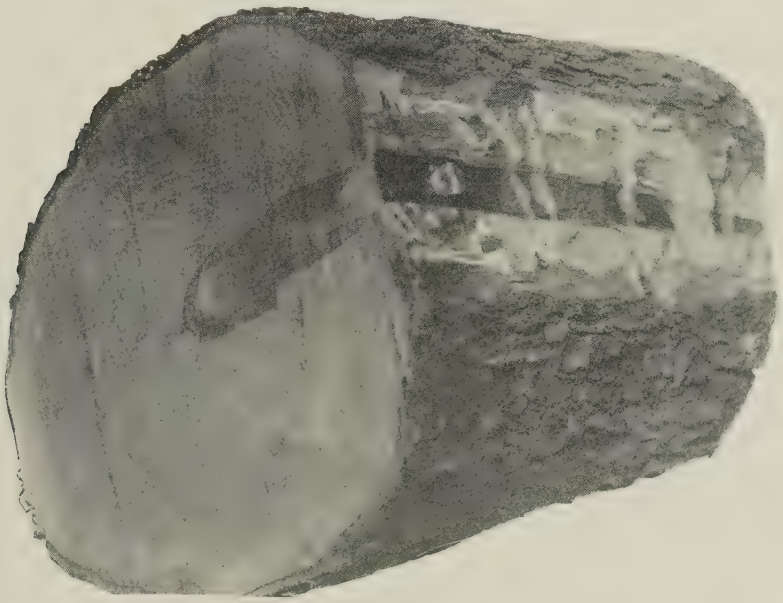

FIG. 19.—*Section from the body of the tree shown above. Note the plug where the remedy was introduced, and the dead and blackened wood extending into the heart of the tree.*

charcoal to color it and some asafetida to give it an effective odor. The retail price of this odoriferous charcoal-sulfur mixture was $3.60 per pound. Correspondence with a large number of growers reported to have used this remedy with success, indicated that their experience was almost uniformly that of ours at the Station, that is, *worthless as a preventive of the disease and injurious to the trees.*

Experiments with four other remedies were made this spring in the pear orchard of Mr. Ira Pease, near Oswego, N. Y., but owing to the fact that very little Blight appeared in the part of the orchard where the experiments were made, no conclusions can be drawn. So far as

observed, however, no injurious effects have as yet followed their application. Of the four remedies used in this experiment, two were applied as washes or paints to the body or limbs of the tree while the other two were poured about the roots.

Controlling the Blight in the orchard. We are prepared to say and ready to demonstrate that this disease can be controlled in the orchards of this State. The following plan of operations properly performed has been demonstrated to be effective both in our hands and in the hands of the grower.

FIG. 20.—*Canker extending downward from cankered stub of previous season. Cleaned out, ready for disinfection and painting.*

General plan of operations for the season:

(1) Destroy all sources of infection, i. e., clean out all cankers (Fig. 20) in the apples, pears and quinces, cutting well into the healthy tissue and removing the diseased bark. Disinfect the cut with corrosive sublimate solution, 1 part to one thousand of water (easily made up by adding one of the tablets, Fig. 2, purchased at any drug store to a pint of water). This solution may be carried in a bottle or wooden pail and applied to the wound with a sponge. Fig. 2 shows outfits that have proved very effective in actual practice. This disinfection may seem to the grower at first to be unprofitable and unnecessary. However, he will soon appreciate its importance if it is omitted. Clean up old pear, apple or quince trees in the neighborhood that may harbor the disease organisms. If necessary, destroy them. All hawthorns along the fence rows or in nearby pastures should be destroyed also.

(2) Make a regular inspection of *every* tree in the orchard *at least* once a week throughout the growing season, beginning as *soon as the blossoms begin to fall.* It may sometimes be necessary to inspect every day.

(a) Break out all blossom-spurs that show the disease and remove them from the orchard. They should be burned. It will not be necessary to disinfect the wounds made by breaking these out. The removal of

these spurs as soon as they show the disease will prevent the bacteria from getting into the limbs (See Fig. 6). In tall trees use a ladder and also a hook on the end of a long handle.

(b) Rub off with the hands, from the trunks and main limbs, all shoots and watersprouts as fast as they start. This will remove the possibility of the formation of limb and body cankers and save much work in cutting out cankers the following season. It will not be necessary to disinfect such wounds.

(c) Cut out all blighted twigs, shoots and watersprouts (Fig. 22). As indicated above, disinfect the cut with corrosive sublimate. If a long-handled pruner is used the sponge may be attached as shown in Fig. 21, simply touching the cut surface with it as soon as the twig is removed. Remove and destroy all prunings. Always *disinfect the cut or wound not the tools*. If all cut surfaces are disinfected any bacteria left on them by the tools or any brought to them subsequently by insects will be destroyed.

Cutting out the Blight once or twice during the season, when it has become sufficiently serious to frighten the grower, is a waste of time and an injury to the orchard. If it is

FIG. 21.—*Tools, devices, receptacles, used in cutting out and disinfecting. The corrosive sublimate tablets, shown in the bottles, may be purchased at drug store. One tablet to a pint of water makes a 1-1000 solution. To clean out cankers the wooden bucket and the can with the sponge will be found satisfactory. Wet the sponge in the bucket and place it in the can, which is carried at the waist by passing the wires about the body and hooking behind. The bottle tied at the belt or to a strap over the shoulder is convenient, especially when using the pruning hook. Wet the sponge from time to time by tilting the bottle.*

FIG. 22.—*Cutting Twig Blight from young apple trees. This will pay on young apple trees or on pears or quinces of any age, but is unprofitable on old apple trees as the disease seldom injures them seriously.*

not profitable to take it out as fast as it appears one cannot afford to grow pears.

That the above plan of operations is effective and practical, as well as profitable, is shown by the experience of Mr. J. V. Curtis of Hilton, N. Y., who in 1908 undertook the control of this disease in his ten-year-

old pear orchard. His orchard, when planted, consisted of 1,100 trees of several varieties, including a large proportion of Bartletts. During the two years prior to 1908, he had lost 100 of these trees by Blight. Despairing of saving the remainder, he called on the College of Agriculture for advice. We visited his place in the early spring of 1908, examined his trees, and advised the above plan of operation. This scheme he followed to the best of his ability, inspecting the orchard once a week, removing and disinfecting the cuts, with the result that the disease was controlled and a fine crop of pears saved, at a total cost of only $30. By regular and frequent inspections, he was able to detect and remove diseased blossom-spurs and blighted twigs before any considerable injury was done. The total diseased wood cut from his orchard that season could have been carried, he says, in one armful, —this, of course, after the dead wood of the previous season had been removed.

During the summer of 1908, the same season in which Mr. Curtis so successfully controlled the Blight in his orchard, the disease broke out in epidemic form in the fine Bartlett pear orchards about Oswego, N. Y. One of the growers, Mr. Ira Pease, having suffered heavy losses, appealed to the Department of Plant Pathology for assistance in putting his trees in shape and for controlling the malady in 1909. As indicated in the introduction, a field laboratory was established at Mr. Pease's place and a trained man, Mr. Mitchell, put in charge. His problem was the removal of dead limbs and hold-over cankers, and the control of the disease during the season by the methods above outlined. The results were all that could be desired. Infections appeared in abundance in many of the trees shortly after blossoms fell, but the diseased spurs were promptly removed and no large limbs had to be cut out as a result of new infections. Many of the old cankers, which had escaped notice during the spring pruning, proved to be active and necessitated severe cutting of a few of the trees during the season. By the end of August, the Blight was practically eradicated from the orchard. There was practically no loss of fruit as had been the case the previous season, and but little of the growth of 1909 had to be removed. Considering that one man had nearly twelve acres of pears to inspect, most of which were Bartletts, and twenty to thirty years old, it is remarkable that he controlled the disease so well. It is true the infections were not so numerous as in 1908, some sections of the orchard showing very few infections, but that they would have proved destructive had they not been promptly removed is shown by the fact that an orchard just across the road showed many blighted limbs by autumn. Mr. Brownell, a

neighbor of Mr. Pease, also very effectively controlled the disease in his large pear orchard by systematic inspection, cutting out and disinfecting. We again emphasize the point that it is the *frequent inspection* and the *disinfection* of wounds made in cutting out that is effective.

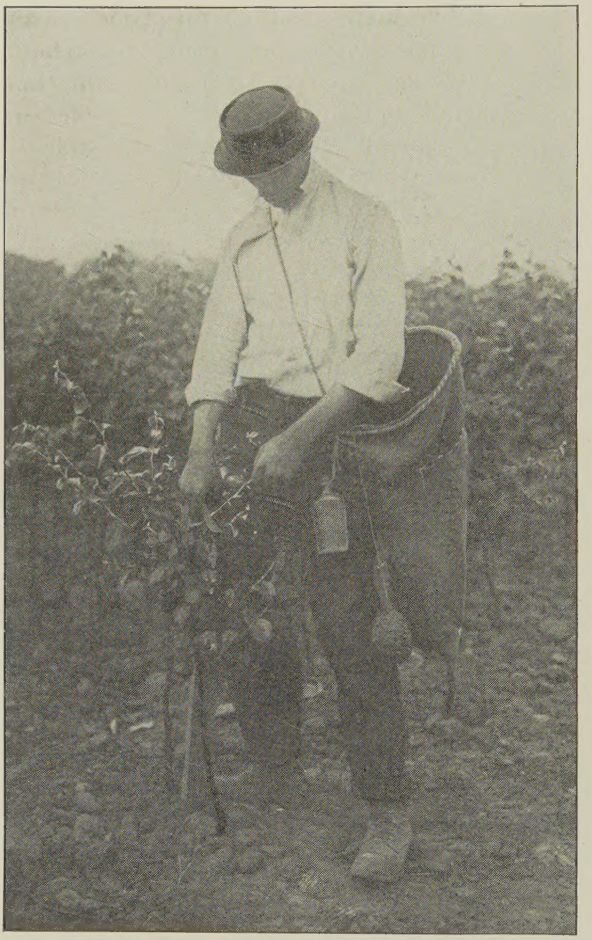

FIG. 23.—*Cutting Blight from nursery stock. Note the bag into which the blighted shoots are put, the bottle of corrosive sublimate and the sponge at the end of a string.*

Controlling the Blight in nursery stock. As indicated on page 38, Dansville nurserymen suffered serious losses from this disease in 1908. We visited the nurseries during the summer, but it was then too late to save the stock. A few of the growers had done some cutting out, but none had disinfected. Most of the growers stood by helpless and saw their profits disappear. Entire blocks of apples, pears and quinces were wiped out, not a tree escaping. For many years the nurserymen about Geneva have suffered more or less from this malady. In the spring of 1909 a co-operative arrangement was made with C. W. Stuart & Co., of Newark, N. Y., for the purpose of studying and demonstrating the control of Blight in one of their nurseries near Orleans, N. Y. The junior writer established a temporary field laboratory at the nursery, remaining on the ground constantly from June 4 to Sept. 1. By systematic inspection and removal of the

Blight (Fig. 23) from the 130 acres devoted to pear, apple and quince stock, he was able effectively to prevent an epidemic of the malady and reduced the losses to a low figure, as shown by the following table.

	Apples	Pears	Quince	Total
No. of trees from which blighted shoots only were removed	834	32	1451	2317
No. trees entirely removed	83	7	256	346

The heavy cuttings made in the quinces were necessary owing to numerous cases of Blight carried over in old cankers from the previous season. From these sources the germs spread, causing infections in the new growth before an effort could be made to control it. A large number of the quince trees entirely removed were killed by infections of the previous season. Many of the 83 apples were first-year buds consisting of a single succulent shoot. These blight rapidly. It is evident from the above figures that at least 2,317 trees were saved by prompt pruning and disinfection. This does not include the large number of others that were entirely protected from the disease by removal of the blighted trees and shoots that would have served as sources of infection had they been left. From our observation during 1909, it seems certain that plant lice were the chief agents in spreading the infection. Dipping the lice-infested shoots in whale-oil soap dip, 7 pounds to 50 gallons of water, was found very effective in controlling the lice, and thus indirectly in checking the progress of the Blight.

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